6 Porbeagle in the Northeast Atlantic (subareas 1–14)

6.1 Stock distribution

WGEF has traditionally considered that there is a single stock of porbeagle *Lamna nasus* in the Northeast Atlantic. The stock occupies the entire ICES area (subareas 1–14) and extends from the Barents Sea to Northwest Africa. For management purposes the southern boundary of the stock is 36°N and the western boundary at 42°W. The information to identify the stock unit is provided in the Stock Annex (ICES, 2011).

Although there is one record of one porbeagle tagged off Ireland and recaptured in American waters (Cameron *et al*., 2018) and genetic studies suggesting that gene flow has occurred across the North Atlantic (Pade, 2009), studies using pop-up satellite archival tags (PSATs) have shown a return migration pattern in the eastern Atlantic without crossing the western boundary of the stock at 42° W (Figure 6.1a and 6.1b). Additionally, of ca. 2000 conventional tags deployed in the NW Atlantic, none of the 209 recaptures (up to 2012) showed a transatlantic migration (Campana *et al*., 2013).

Tag deployments have also provided evidence of site fidelity to spring–summer feeding areas (Biais *et al*., 2017; Cameron *et al*., 2019). This result suggests that porbeagle stock components may have limited connectivity between them. To investigate this possibility, an assessment of the genetic structure of the porbeagle migrating to the Bay of Biscay in spring-summer was carried out in 2020–2021 (Viricel *et al*., 2021 WD02). Preliminary results suggest that stock structure could be more complex than currently assumed.

6.2 The fishery

6.2.1 History of the fishery

The main country catching porbeagle in the last decade was France and, to a lesser extent, Spain, UK and Norway. The only regular target fishery that has existed recently was the French fishery (although there have been seasonal target fisheries in the UK). However, historically there were important Norwegian and Danish target fisheries. Porbeagle is also taken as a bycatch in mixed fisheries, mainly in UK, Ireland, France and Spain. A detailed history of the fishery is in the Stock Annex (ICES, 2011).

Information presented to WGEF 2015 indicated that the Norwegian catch decline in the 1950s and 1960s did not simply reflect a decline in abundance, but also has been influenced by a decrease in effort (Biais *et al*., 2015a WD). The discovery of good fishing grounds off Ireland in 1960 and the failure to find the same abundance on these grounds in the two following years likely played a significant role in the 1960–1963 catch decline (Figure 6.2). Available data on the mean weights of fish indicate that this fishery off Ireland was located on nursery areas (Biais *et al*., 2015b WD). Analyses of long-term landings data need to be interpreted in relation to catch per unit of effort experienced by this fleet in both the Northeast and Northwest Atlantic fishing grounds, as well as other factors (e.g. other fishing opportunities).

6.2.2 The fishery in 2020

No EU fishery has been allowed since the implementation of a zero TAC in 2010. However, some limited landings have been reported since 2010, as well in the previous five years (Table 6.1). The

2021 WGEF estimated landings is 6 t in 2020 and since the zero TAC was implemented in 2010, the mean (2010–2019) WGEF estimate is 25 t per year. However, since 2010 data must be considered as unrepresentative of removals, as dead discards are not quantified.

6.2.3 ICES advice applicable

The 2019 advice is valid for 2020–2023, and stated: "*ICES advises that when the precautionary approach is applied, there should be zero catch in each of the years 2020–2023*".

6.2.4 Management applicable

EC Regulation 1185/2003 prohibits the removal of shark fins and subsequent discarding of the body of this species. This regulation is binding on EC vessels in all waters and non-EC vessels in Community waters.

EC Regulation 40/2008 first established a TAC (581 t) for porbeagle taken in EC and international waters from ICES Subareas 1–12 and 14 for 2008. The TAC was reduced by 25% in 2009 and a maximum landing length of 210 cm (fork length) was implemented.

From 2010–2014, successive EC Regulations (23/2010, 57/2011, 44/2012, 39/2013 and 43/2014) had established a zero TAC for porbeagle in EU waters of the ICES area and prohibited EU vessels to fish for, to retain on board, to tranship and to land porbeagle in international waters.

Since 2015 it has been prohibited for EU vessels to fish for, to retain on board, to tranship or to land porbeagle, with this applying to all waters (Council Regulation (EU) 2015/104, 2016/72, 2017/127, 2018/120, 2019/124, 2020/123 and 2021/92). *Fisheries consultations between the UK and the EU in 2021 have also included porbeagle in the list of prohibited species in Union and UK waters*[1].

It has been forbidden to catch and land porbeagle in Sweden since 2004; and in 2007, Norway banned all direct fisheries for porbeagle but bycatch could be landed up to 2011. Since that year, live specimens must be released, whereas dead specimens can be landed, but this was not mandatory. The species is therefore exempt from the general Norwegian landings obligation, and the payment is therefore withdrawn, except for 20% to cover the cost of landing.

In 2017, a regulation was issued to ban all targeted fishing in Icelandic waters for spurdog, porbeagle and basking shark and stipulating that all viable catch in other fisheries must be released.

6.3 Catch data

6.3.1 Landings

Landings of porbeagle in the Northeast Atlantic from 1926 to 2020 are shown in Table 6.1a and 6.1b and Figure 6.3 and 6.4. From 1971 onwards, France remained the major contributor. The Danish time-series for 1946–1949 was completed at the 2015 WGEF, using the information collected for analysing the trends in the Northern European porbeagle fishery (Biais *et al*., 2015a WD).

More detailed information on landings is presented in the Stock Annex.

[1] Fisheries: consultations between the UK and the EU in 2021 - GOV.UK (www.gov.uk)

6.3.2 Discards

Because of the high value of this species, it is likely that specimens caught incidentally were landed prior to quota becoming restrictive. Historical discards are consequently thought to be low. The EU adoption in 2009 of a maximum landing size for this species likely led to increased discarding of large fishes by vessels from the French directed fishery, although the proportion of large fish was low in the landing of this fishery (< 5%; Hennache and Jung, 2010).

In recent years, the only discard estimate available was provided by France in 2018: 88 t (bottom trawls: 57 t; nets: 26 t; pelagic trawls: 5 t). This estimate suggests that discards can be of the same order of magnitude as the non-directed catches prior to porbeagle being on the fishing ban: 49 t in 2007–2009 for trawls and nets. However, it should be noted that this may be an imprecise estimation as the underlying data relate to few observations and specimens. Anecdotal information suggests that French pelagic trawlers and tuna long liners discard porbeagle, but their total dead discards are unknown.

Current levels of discarding are uncertain, and may seasonally occur in some métiers. For example, observations on porbeagle bycatch have been made for some gillnetters operating in the Celtic Sea (Bendall *et al.*, 2012a, b; Ellis and Bendall, 2015 WD), but there are no estimates of total dead discards.

Data analysis on at-sea observer programme for UK (E&W) fisheries, indicate that porbeagle encountered up to the end of 2009 were typically retained (32% discarded) and that since the introduction of the fishing ban, all observed were discarded (Silva and Ellis, 2019).

Anecdotal information indicates that porbeagle is a regular bycatch in the Norwegian pelagic trawl fishery for blue whiting in the Norwegian Sea. Due to the fishing method, whereby the catch is pumped on board, all specimens are reportedly dead when caught. It was also suggested that there is an increased occurrence of porbeagle in this fishery since 2014/2015. The lack of observer coverage on these vessels means that such observations have not been independently verified.

This species is taken by recreational fishers in some areas, however the full extent of fish captured through this method has not been quantified.

6.3.3 Quality of catch data

Some EU nations have incomplete recording of porbeagle (e.g. they have been reported as generic sharks; have been captured by <10 m LOA vessels). Although catch data for this stock are considered to be underestimated, these are mostly for nations catching small quantities, and more comprehensive data are available for the main fishing nations. Since the zero TAC / prohibited listing was introduced, reported landings are not representative of catch. There are no estimates of recent catches, as only limited data from discard observer trips are available for porbeagle. Furthermore, it is unclear as to whether these data would be sufficiently representative to provide robust estimates of dead removals. The 2005–2015 EU Member States, Norwegian and Icelandic landing have been revised in 2016. Major revisions relate to 2008 and 2009 for French and Spanish landings.

6.3.4 Discard survival

Data on discard survival are limited. Bendall *et al.* (2012a) examined the vitality of porbeagle caught in gillnet fisheries, and only four (20%) of the 20 fish captured were alive. It is important to recognise that this study was based on a small sample size and the soak time was shorter than that adopted by normal fishing operations. Survival on longlines is likely to be much higher, but would depend on soak time. Fishers have reported mortality of porbeagle caught in pelagic trawl fisheries, but this has not been quantified.

6.4 Commercial catch composition

Only limited length data are available. However, length-distributions by sex are available for 2008 and 2009 for the French longline fishery that targeted porbeagle until 2009 (Hennache and Jung, 2010; Figure 6.5). These distributions are considered representative of international catches because during that period France was the major contributor to catch figures.

The composition by weight class (< 50 kg and ≥ 50 kg) of the French fishery catches reveals that the proportion of large porbeagle in the landings was higher before 1998 than after 2003 but with large inter-annual changes (Table 6.2).

Catch data derived from the French longline fishery highlighted the dominance of porbeagle (89%) on the total catch. Other species included blue shark (10%), common thresher (0.6%) and tope (0.3%).

6.4.1 Conversion factors

Length–weight relationships are available for different geographic areas and for time periods (Table 6.3). Relationships between alternative length measurements with total length in porbeagle were presented in 2015 (Table 6.4; Ellis and Bendall, 2015 WD).

6.5 Commercial catch and effort data

A new CPUE series from Norwegian porbeagle longlines (1950–1972) was presented in 2015 (Biais *et al.*, 2015b WD). Personal logbooks of three fishermen (covering periods of three, 10 and 15 years) were used to get this new series. Data were reported for each fishing day of the trip, including days with zero catch. Most of the fishing days were in northern European waters (divisions 2.a, 4.a-b, 5.a and 6.a (north of 59°N)), the historical Norwegian fishing zone, but some data were also available for fishing days west of the British Isles, including the Celtic Sea.

The time-series trend in this area was explored by carrying out a GLM on log transformed values fitted with a gamma link function. The annual index series provided by this analysis showed no significant temporal trend (Figure 6.6). The CPUE series was revised in 2021 to assign fishing days to rectangles of one degree in latitude and one degree in longitude. This enabled the definition of six areas better in line with the distribution of high daily catches, compared to when allocating to ICES subdivisions. An annual index series was obtained by carrying out a GLM on log transformed values fitted with a gamma link function, using the new areas. This revision continues to show no significant trend (Biais, 2021 WD07).

A CPUE series based on data collected from 17 boats belonging to the French longline fishery was presented by Biais and Vollette (2009). These boats landed more than 500 kg of porbeagle per year during more than six years after 1972 and more than four years from 1999 onwards. The latter allowed inclusion of a vessel that had entered the fishery towards the end of the time-series, given the limited number of boats in recent years.

At the 2009 ICCAT-ICES meeting, standardized catch rates were also presented for North Atlantic porbeagle during the period 1986–2007, caught as low prevalent bycatch in the Spanish surface longline fishery targeting swordfish in the Atlantic Ocean (Mejuto *et al.*, 2009). The analysis was performed using a GLM approach that considered several factors such as longline type, quarter, bait and also spatial effects by including seven zones.

The nominal and the standardized catch rate series of the French fleet show that higher values occurred by the late 1970s (Figure 6.7). Since then, CPUE has varied between 400–900 kg per day without showing a trend.

The caution with which trends over short periods must be considered was shown by an analysis of the effect of porbeagle aggregating behaviour, as well as an effect of cooperation between skippers. The analysis was carried out for years 2001–2008 for which detailed data were available (Biais and Vollette, 2010). The analysis showed that inter-annual variation in local abundance may be higher than indicated by catch by trip or catch by day.

Spanish data showed a higher variability than the French (Figure 6.8), possibly as they were based on bycatch data and derived from fishing fleet that operate in areas with lower abundance of porbeagle.

6.6 Fishery-independent surveys

An abundance survey was carried out in May–June 2018 and 2019 by France (Ifremer) on board a chartered longliner (Biais, 2019 WD). The longline was the same as that formerly used by commercial vessels, but shorter on average (336 hooks per set; 1 or 2 sets per day). A sampling protocol with fixed stations was adopted, as in the Western Atlantic (Campana *et al*, 2013). The survey area stretches from latitudes 45° to 48° N along the shelf edge (depths from 700 to 4000 m) westwards of France. The survey grid includes 32 stations: two by statistical rectangle of the survey area. One to three longline sets were carried out on each of them with the condition to have at least 10 days between two sets. The abundance index (average CPUE) are consistent between them: 3.6 fish/336 hooks in 2018 and 3.0 fish/336 hooks in 2019.

A comparison of these results with a commercial CPUE series was made possible by the availability of a skipper's diaries (Biais, 2019 WD). Detailed information of these diaries allowed several selections of longline sets to get a CPUE series comparable to the survey index:

- If the vessel stays in the same statistical rectangle more than one day, the sets of the following days are not selected before 10 days;
- If two sets are made in the same statistical rectangle the same day, the second set is selected only if the distance between the two sets is larger than the distance between the two stations of the survey in this statistical rectangle;
- If the vessel moves to another statistical rectangle, the set is selected only if its distance from the preceding set is larger than the distance between the two stations of the survey in this statistical rectangle.

Survey indices are close to the mean CPUE of this commercial time series (Figure 6.9). This result and inter-annual consistency of survey indices allow thinking that the design of the survey is relevant to provide abundance indices. Furthermore, the comparison with the commercial CPUE series suggests that the porbeagle mean abundance on the shelf edge westwards of France of 2018–19 is at similar levels than the mean abundance of 2005–2009, if we are considering the recent survey area with previous commercial data. However, it should be noted that the commercial CPUE may be biased upwards because commercial sets are not deployed all over the survey area but in ICES statistical rectangles where the skipper expected the best CPUE (6–12 out of 16, depending of the year).

To show the effect of the possible bias caused by the lack of commercial CPUE for part of the survey area, the survey index was calculated using only data from the 10 statistical rectangles where the CPUE are the largest each year (corresponding to the removal of statistical rectangles with an average CPUE < 1 in 2018 and <= 1.5 in 2019). The reason to look at these data in such a way, relates to the fact that fishermen in order to make fishing activity commercially viable, would likely not operate in areas with low CPUE, moreover when these ICES statistical rectangles are close to each other. The average survey index for the period 2018–2019 is thus 4.5, which is 30% higher than the average of the commercial CPUE for the period 2005–2009.

Because the increase in modes of the porbeagle length distribution from 2008–2009 to 2018–2019 (Figure 6.10), an increase in biomass from 2009 to 2019 is even more likely.

6.7 Life-history information

Life-history information (including habitat description) is presented in Stock Annex.

Nicolaus *et al.* (2015 WD) reported high levels of mercury (Hg) in both the red and white muscle of porbeagle (n = 33) caught in the Celtic Sea. Hg concentrations in either the red or white muscle that exceeded the maximum levels established in European regulations for seafood were observed in a third of specimens. Hg concentration, however, increased with length, and all fish > 195 cm total length had concentrations > 1.0 mg kg^{-1}, with a maximum observed value of 2.0 mg kg^{-1}.

6.7.1 Movements and migrations

Migrations of three porbeagle tagged off Ireland with archival pop-up tags (PAT) in 2008 and 2009 are described by Saunders *et al.* (2011). One specimen migrated 2400 km to the northwest off Morocco, residing around the Bay of Biscay for about 30 days. The other two remained in off-shelf regions around the Celtic Sea/Bay of Biscay and off western Ireland. They occupied a vertical distribution ranging from 0–700 m and at temperatures of 9–17°C, but during the night they preferentially stayed at upper layers.

The UK (CEFAS) launched a tagging program in 2010 to address the issue of porbeagle bycatch and to further promote the understanding of porbeagle movement patterns in UK marine waters. Altogether, 21 satellite tags were deployed between July 2010 and September 2011, and 15 tags popped off after two to six months. However, four tags failed to communicate. The tags attached to sharks in the Celtic Sea generally popped off to the south of the release positions while those to sharks off the northwest coast of Ireland popped off in diverse positions. One tag popped off in the western part of the North Atlantic, one close to the Gibraltar Straits and another in the North Sea. Several tags popped off close to the point of release (Bendall *et al*., 2012b).

In June–July 2011, France (IFREMER and IRD) joined the international tagging effort in cooperation with CEFAS by undertaking a survey on the shelf edge in the West of Brittany. A second survey was carried out in 2013 by Ifremer. Three PATs were deployed by IFREMER-IRD and three by CEFAS (results in Bendall *et al*., 2012a) during the 2011 survey, and nine during the 2013 survey. Pop-off dates were set at twelve months for the PSATs deployed by France which were all used to tag large females (L_T > 2 m). Eight PSATs popped up after four months and four at twelve months. Track reconstructions, based on Grid Filtering, were carried out for these eight tags (Biais *et al*., 2017). They revealed large migrations of the sharks; going from the Bay of Biscay northward to the Arctic Circle, southward to Madeira and three fish moved westwards to the Mid-Atlantic Ridge. A general circular migration pattern was observed with a return to the Bay of Biscay or the SW Celtic Sea shelf edge when PSATS popped up at 12 months. In these cases, the small observed distances between tagging and pop-up positions (mean 190 km) are remarkable given that movements could be of several thousand km.

An exploratory abundance survey for porbeagle in the Bay of Biscay was undertaken by France in summer 2016, including the deployment of 7 PATs. One PAT never transmitted, three premature pop-ups (< 1 month) were observed and one PAT transmitted in February just off the northwest coast of Spain. The two remaining PATs popped up on schedule at 12 months. The corresponding estimated tracks show again that porbeagle has an annual circular migration pattern. These PAT deployments were completed in 2018 by the tagging of 31 porbeagle during the 2018 French abundance survey. Twenty-nine of these 31 PATs popped up at more than 4 months and 12 at one year (average time at liberty is 280 days). Seven additional PATs have been deployed during the 2019 French abundance survey.

A recent study used landings data from 2005–2019 to investigate the spatial distribution of porbeagle along the Norwegian coast, with one hotspot area identified in summer around Trondheim (Central Norway) (MSc thesis, Triginer 2020).

6.7.2 Reproductive biology

A research programme carried out by the NGO APECS (Hennache and Jung, 2010) provided information based on a large sampling (n = 1770) on the French catch in 2008–2009. Spatial sex-ratio segregations are documented and information is provided on the likelihood of a nursery ground in St. George's Channel and of a pupping area in the grounds along the western Celtic Sea shelf edge. Further evidence of parturition close to the western European shelf was provided by the captures of 9 new born pups on the Bay of Biscay shelf break in May 2015 and July 2016 (Biais *et al.*, 2017) as well as by the captures of pregnant females during the 2018 abundance survey.

Two catches of gravid females containing large embryos (60–63 and 66–76 cm T_L) were also reported in East-Scotland and around Shetland in May and June, indicating that parturition is in the summer or autumn (Gauld, 1989). They suggest that another pupping ground may be situated in this area with a later parturition than in southern waters.

6.7.3 Genetic information

A first study of the genetic diversity (mitochondrial DNA haplotype and nucleotide diversities) was carried by Pade (2009). This study was based on 156 individuals caught both on the Northeast and Northwest Atlantic; the results obtained show no significant population structure across the North Atlantic. These findings were supported by another study which examined 224 specimens from eight sites across the North Atlantic and the Southern Hemisphere (Testerman, 2014). However, this study showed strong genetic difference between the North Atlantic and Southern Hemisphere, which indicates two genetically distinct populations

Pade (2009) found also that while the mtDNA haplotype diversity was very high, sequence diversity was low, which suggests that most females breed in particular places, which also indicates the stock is likely to be genetically robust (Pade, 2009).

In an on-going genetic study, Viricel *et al.* (2021 WD02) observed also high levels of genetic diversity at the mitochondrial DNA control region in North Atlantic, using 49 individuals caught in the Bay of Biscay from 2013 to 2019, 6 individuals from the Indian ocean and 155 sequences obtained from Genbank from both North and South Atlantic. Preliminary results show significant differences between haplotype frequencies of two groups of individuals tagged in the Bay of Biscay, according to migrations towards the West or towards the North in Autumn-Winter. However, it should be noted that these results were obtained using a single locus and a low sample size for the two migratory groups (N = 9–10 individuals) and thus, viewed with caution. Therefore, the hypothesis that porbeagle stock in the NE Atlantic may include distinct populations will be further investigated using nuclear markers in 2021.

Further studies examining genetic structure of Mediterranean Sea porbeagle are still required.

6.8 Exploratory assessment models

6.8.1 Previous studies

The first assessment of the Northeast Atlantic stock was carried out in 2009 by the joint ICCAT/ICES meeting (ICCAT, 2009; ICES, 2009) using a Bayesian Surplus Production (BSP) model (Babcock and Cortes, 2009) and an age-structured production (ASP) model (Porch *et al.*, 2006). The 2009 assessments have not been updated since.

Using the French CPUE series as well as the Spanish CPUE series, stock projections based on the BSP model demonstrated that low catches (below 200 t) may allow the stock to increase under most credible model scenarios and that the recovery to B_{MSY} could be achieved within 25–50 years under nearly all model scenarios. However, it is important to recognise both the uncertainty in the input parameters for this assessment and the low productivity of the stock. More detailed results from these are detailed in the Stock Annex.

6.8.2 The SPiCT model

In 2018, a working document (Albert, 2018) has presented different exploratory runs of the SPiCT model (Pedersen and Berg, 2016). They were based on the French CPUE index available for the years 1972–2007 (Figure 6.7) and landings data from 1950–2016 (presented in the 2017 WGEF report; ICES, 2017).

The best results were from runs that used the full set of landing data (1950–2016). They indicate that the stock biomass is either above or not too far below B_{MSY} in final year. With the present F far below F_{MSY}, a commercial porbeagle fishery may therefore again become advisable in the near or medium-term future. However, these exploratory runs need to be further scrutinized before the results can be considered as indicative of the present status of the stock. Details are in the 2018 WGEF report (ICES, 2018).

In 2021, other SPiCT runs were presented (Biais, 2021 WD07). The consistency between the SPiCT and BSP assessments was examined with a SPiCT run carried out with the same data and parameters as the run referenced NE1 of the previous BSP assessment (ICCAT, 2009). Both models agree on the order of magnitude of K and Bmsy, but B/Bmsy in terminal year is higher for the BSP model. Additional SPiCT runs were carried out with the Norwegian CPUE series. For this first exploratory assessment using CPUEs spanning to the period of high catches after WWII, the runs were stopped in 1970 to assess trends in biomass and mortalities with catches and CPUE from the same fishery. The B/Bmsy estimates are uncertain, possibly because the CPUE trend is flat. However, further analysis of this CPUE series is needed as recent analysis of the Norwegian logbooks in 2021 provided with a better precision of CPUE locations.

6.9 Stock assessment

Since the closure of the fishery and the designation of porbeagle as a prohibited species, there are insufficient commercial data (and fishery-independent data) with which to ascertain the current status of the stock.

In order to close data gaps and identify important areas for life-history stages (e.g. mating, pupping and nursery grounds), ICCAT has encouraged research and monitoring projects at stock level to start in 2017 (ICCAT, 2016).

6.10 Quality of assessments

The assessments (and subsequent projections) conducted at the joint ICCAT/ICES meeting that are summarized in the Stock Annex were considered exploratory assessments, considering the assumptions (carrying capacity for the SSB model, F in the historic period in the ASP model) and available data, (particularly a lack of CPUE data for the peak of the fishery; uncertainty in some of the landings data). Consequently, the model outputs were considered highly uncertain (ICCAT, 2009) and in 2009 and subsequent years, WGEF considered that there was insufficient new information to inform on current stock status.

Available CPUE from Norwegian vessels showed no trend from 1950 to 1972. This information, provided at the 2015 WGEF, also suggests that the northern fisheries ceased partly because of the attraction of other fisheries. It underlines also that economic and social factors are important considerations in explaining why a fishery may not operate or resume even if the abundance does not decline. An update of the ICES/ICCAT assessment should consider these new data as well as recent fishery-independent data.

6.11 Reference points

ICCAT uses F/F_{MSY} and B/B_{MSY} as reference points for stock status of pelagic shark stocks. These reference points are relative metrics rather than absolute values. The absolute values of B_{MSY} and F_{MSY} depend on model assumptions and results and are not presented by ICCAT for advisory purposes.

6.12 Conservation considerations

At present, the porbeagle shark subpopulation of the Northeast Atlantic is listed as Critically Endangered in the IUCN red list (Ellis *et al.*, 2015).

In 2013, a renewed proposal to list porbeagle shark on Appendix II of CITES was accepted at the Conference of Parties (16) Bangkok, and it has been listed since September 2014.

6.13 Management considerations

WGEF/ICCAT considered all available data in 2009. This included updated landings data and CPUE from the French and Spanish fisheries. Collation of historical information, as provided in 2015, supports the need to update the ICCAT/ICES assessment.

The new CPUE series provided for the Norwegian fishery from 1950 to 1972 further highlights the difficulties in interpreting stock trends with contrasting trends in CPUE and landings.

In the absence of target fisheries and reliable information on bycatch and discards, one or several dedicated longline surveys covering the main parts of the stock area would be needed if stock status is to be monitored appropriately. The surveys carried out by France in 2018 and 2019 have shown that a fixed stations survey design can provide consistent annual indices. A 2000–2009 commercial series drawn up with selections to make it comparable to the survey indices (elimination of repeated sets of longlines) provides further evidence of consistency of the survey results. The comparison of 2018–19 survey indices with this 2000–2009 CPUE series and the increase in modal length of catches from 2009 to 2019 suggest that the biomass of the population that come back to the Bay of Biscay and the Celtic Sea in spring-summer has increased in recent years.

Continuing this spring-summer survey with an expansion to other areas within the stock distribution would be advantageous, as this would provide the necessary sampling effort to take the large distribution of porbeagle into account in order to monitor stock size.

This species has low population productivity, and is thus highly susceptible to overexploitation. Consequently, WGEF considers that target fishing should not proceed without a programme to monitor stock abundance. Current fishing ban may prove difficult to obtain a more robust estimate of discards, which are considered to have increased in recent years in the Bay of Biscay as well as in northern part of the distribution area of the stock. WGEF also highlight that the present fishing ban hampers any quantitative assessment of current stock status.

A maximum landing length (MLL) was adopted by the EC in 2009. It constituted a potentially useful management measure in targeted fisheries, as it should deter targeting areas with mature females. However, there are also potential benefits from limiting fishing mortality on juveniles. Given the difficulties in measuring (live) sharks, other body dimensions (e.g. height of the first dorsal fin or pre-oral length) that could be pragmatic surrogate measurements could usefully be identified. The correlation of some measurements with fork length is high (Bendall *et al*., 2012a) but further studies, so as to better account for natural variation (e.g. potential ontogenetic variation and sexual dimorphism) in such measurements, are needed to identify the most appropriate options for managing size restrictions.

Further ecological studies on porbeagle, as highlighted in the scientific recommendations of ICCAT (2009), would help to further develop management measures for this species. Such work could usefully build on recent and on-going tagging projects, and various Member States have undertaken increasing studies on porbeagle.

Studies on porbeagle bycatch should be continued to develop operational ways to reduce bycatch, to decrease at-vessel mortality and to improve the post-release survivorship of discarded porbeagle.

All fisheries-dependent data should be provided by the Member States having fisheries for this stock, as well as other countries longlining in the ICES area.

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Table 6.1a. Porbeagle in the Northeast Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1926–1970). Data derived from ICCAT, ICES and national data. Data are considered an underestimate.

Year	Estimated Spanish data	Denmark	Norway (NEA)	Scotland	Total
1926			279		279
1927			457		457
1928			611		611
1929			832		832
1930			1505		1505
1931			1106		1106
1932			1603		1603
1933			3884		3884
1934			3626		3626
1935			1993		1993
1936			2459		2459
1937			2805		2805
1938			2733		2733
1939			2213		2213
1940			104		104
1941			283		283
1942			288		288
1943			351		351
1944			321		321
1945			927		927
1946		1400	1088		2488
1947		3300	2824		6124
1948		2100	1914		4014
1949		1700	1251		2951
1950	4	1900	1358		3262
1951	3	1600	778		2381
1952	3	1600	606		2209
1953	4	1100	712		1816
1954	1	651	594		1246
1955	2	578	897		1477
1956	1	446	871		1318
1957	3	561	1097		1661
1958	3	653	1080	7	1743
1959	3	562	1183	9	1757
1960	2	362	1929	10	2303
1961	5	425	1053	9	1492
1962	7	304	444	20	775
1963	3	173	121	17	314
1964	6	216	89	5	316

Year	Estimated Spanish data	Denmark	Norway (NEA)	Scotland	Total
1965	4	165	204	8	381
1966	9	131	218	6	364
1967	8	144	305	7	464
1968	11	111	677	7	806
1969	11	100	909	3	1023
1970	10	124	269	5	408

Table 6.1b. Porbeagle in the Northeast Atlantic. Working Group estimates of porbeagle landings data (tonnes) by country (1971–2020). Data are considered an underestimate for some (minor) fishing countries. Data are derived from ICCAT, ICES and FAO data, National reports and data bases and 2015–2021 Data calls. Note: '.' = zero catch ; '+' = < 0.5 t; NA – data not available. Faroe Is. data from 2015–2020 have been revised in 2021 (source: https://statbank.hagstova.fo).

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
Denmark	311	523	158	170	265	233	289	112	72	176	158	84	45	38	72
Faroe Is	1	.	5	.	.	1	5	9	25	8	6	17	12	14	12
France	550	910	545	380	455	655	450	550	650	640	500	480	490	300	196
Germany			6	3	4	.	.	.	.	.	.	.	.	.	.
Iceland			2	2	4	3	3	.	1	1	1	1	1	1	1
Ireland			.	.	.	.	.	.	.	.	.	.	.	.	.
Netherlands			.	.	.	.	.	.	.	.	.	.	.	.	.
Norway	111	293	230	165	304	259	77	76	106	84	93	33	33	97	80
Portugal			.	.	.	.	.	.	.	.	.	.	.	.	.
Spain	11	10	12	9	12	9	10	11	8	12	12	14	28	20	23
Spain (Basque Country)															
Sweden			.	.	3		.	5	1	8	5	6	5	9	10
UK (E,W, NI)		4	14	15	16	25	.	.	1	3	2	1	2	5	12
UK (Scot)	7	15	13	.	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	991	1755	985	744	1063	1185	834	763	864	932	777	636	616	484	406

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Denmark	114	56	33	33	46	85	80	91	93	86	72	69	85	107	73
Faroe Is	12	33	14	14	14	7	20	76	48	44	8	9	7	10	13
France	208	233	341	327	546	306	466	642	824	644	450	495	435	273	361
Germany	.	.	.	.	.	.	.	1	.	.	.	.	2	+	17
Iceland	1	1	1	1	.	.	1	3	4	5	3	2	3	3	2
Ireland	.	.	.	.	.	.	.	.	.	.	.	.	.	8	2
Netherlands	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Norway	24	25	12	27	45	35	43	24	26	28	31	19	28	34	23
Portugal	.	3	3	2	2	1	+	1	1	1	1	1	1	+	15
Spain	26	30	61	40	26	46	15	21	49	17	39	23	22	15	11
Spain (Basque Country)											20	12	27	41	38
Sweden	8	5	3	3	2	2	4	3	2	2	1	1	1	1	1
UK (E,W, NI)	6	3	3	15	9	.	.	.	.	+	.	.	1	6	7
UK (Scot)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	2	NA	NA	NA
TOTAL	399	389	471	462	690	482	629	862	1047	827	628	633	612	498	563

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Denmark	76	42	21	20	3	3	2	2	4	.	2	3	.	.	.
Faroe Is	8	10	14	5	18	21	14	10	13	14	18	25	17	15	7
France	339	439	394	374	295	226	371	330	337	10	2	27	13	2	3
Germany	1	3	5	6	5	+	2	2	+	.	+	+	.	.	.
Iceland	4	2	+	1	+		+	1	1	1	1	1	1	+	+
Ireland	6	3	3	+	3	4	8	7	3	+	.	.	.	.	.
Netherlands	.	.	+	.	+	.	+	+	.	+	.	.	.	.	+
Norway	17	14	19	24	12	27	10	12	10	12	11	17	9	5	4
Portugal	4	11	4	57	+	+	+	+	.	+	+	.	.	+	.
Spain	68	65	44	19	18	87	52	269	150	+	+	+	.	.	.
Sweden	1	.	.	5	+	.	+	+	+	.	.	.	.	.	.
UK	10	7	25	24	24	12	26	15	11	+	+	+	.	.	.
Japan	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	534	596	529	535	378	380	485	648	529	37	34	73	40	22	14

	2016	2017	2018	2019	2020
Denmark	+	+	.	+	+
Faroe Is	3	1	1	1	1
France	+	1	1	2	+
Germany	.	.	.	.	.
Iceland	2	1	1	3	3
Ireland	.	.	.	.	.
Netherlands	.	.	.	+	.
Norway	6	6	3	4	3
Portugal	.	.	.	.	.
Spain	.	.	2	.	.
Sweden	.	.	.	.	.
UK	.	.	.	.	.
Japan	NA	NA	NA	NA	NA
TOTAL	11	9	8	10	6

Table 6.2. Porbeagle in the Northeast Atlantic. Proportion of small (< 50 kg) and large (≥ 50 kg) porbeagle taken in the French longline fishery 1992–2009. Source: Hennache and Jung (2010).

Year	% Weight of in the catches of porbeagle:	
	< 50 kg	> 50 kg
1992	26.0	74.0
1993	29.7	70.3
1994	33.1	66.9
1995	49.9	53.1
1996	31.9	68.1
1997	39.2	60.8
1998	Data not available by weight category	
1999		
2000		
2001		
2002		
2003	53.7	46.3
2004	44.0	56.0
2005	40.0	60.0
2006	44.3	55.7
2007	44.9	55.1
2008	45.9	54.1
2009	51.8	48.2

Table 6.3. Porbeagle in the Northeast Atlantic. Length–weight relationships of porbeagle from scientific studies.

Stock	L-W relationship	Sex	n	Length range	Source
NW Atlantic	$W = (1.4823 \times 10^{-5})\ L_F\ 2.9641$	C	15	106–227 cm	Kohler *et al.*, 1995
NE Atlantic (Bristol Channel)	$W = (1.292 \times 10^{-4})\ L_T\ 2.4644$	C	71	114–187 cm	Ellis and Shackley, 1995
NE Atlantic (N/NW Spain)	$W = (2.77 \times 10^{-4})\ L_F\ 2.3958$	M	39		Mejuto and Garcés, 1984
	$W = (3.90 \times 10^{-6})\ L_F\ 3.2070$	F	26		
NE Atlantic (SW England)	$W = (1.07 \times 10^{-5})\ L_T\ 2.99$	C	17		Stevens, 1990
NE Atlantic (Biscay / SW England/ W Ireland)	$W = (4 \times 10^{-5})\ L_F\ 2.7316$	M	564	88–230 cm	Hennache and Jung, 2010
	$W = (3 \times 10^{-5})\ L_F\ 2.8226$	F	456	93–249 cm	
	$W = (4 \times 10^{-5})\ L_F\ 2.7767$	C	1020	88–249 cm	

Table 6.4. Porbeagle in the Northeast Atlantic. Relationships between alternative length measurements with total length in porbeagle (n = 53), where total length refers to the total length with the upper lobe of the caudal fin flexed down (L_{T_under}) and measured under the body. Relationships given as an equation and in proportional terms (percentage of L_{T_under}). Source: Ellis and Bendall (2015 WD).

Measurement	Equation	r^2
Total length (depressed), measured over body (L_{T_over})	$L_{T\_over} = 1.0279.L_{T\_under} – 0.3109$	0.99
Total length (natural), measured under body (L_{N_under})	$L_{N\_under} = 0.9906.L_{T\_under} – 3.9749$	0.99
Total length (natural), measured over body (L_{N_over})	$L_{N\_over} = 0.9979.L_{T\_under} – 1.0713$	0.99
Fork length, measured under body (L_{F_under})	$L_{F\_under} = 0.877.L_{T\_under} – 3.6981$	0.99
Fork length, measured over body (L_{F_over})	$L_{F\_over} = 0.8919.L_{T\_under} – 1.4538$	0.99
Standard length, measured under body (L_{S_under})	$L_{S\_under} = 0.7688.L_{T\_under} – 2.1165$	0.99
Standard length, measured over body (L_{S_over})	$L_{S\_over} = 0.7849.L_{T\_under} – 0.2599$	0.99
Measurement	**% of L_{T_under} (mean ± SD and range)**	
Total length (depressed), measured over body (L_{T_over})	102.6 ± 1.31 (100.0–106.7)	
Total length (natural), measured under body (L_{N_under})	96.7 ± 1.72 (91.9–101.9)	
Total length (natural), measured over body (L_{N_over})	99.1 ± 1.82 (95.3–102.6)	
Fork length, measured under body (L_{F_under})	85.5 ± 0.99 (83.3–88.9)	
Fork length, measured over body (L_{F_over})	88.3 ± 1.34 (85.2–92.5)	
Standard length, measured under body (L_{S_under})	75.6 ± 1.07 (74.1–79.1)	
Standard length, measured over body (L_{S_over})	78.3 ± 1.34 (75.6–82.2)	

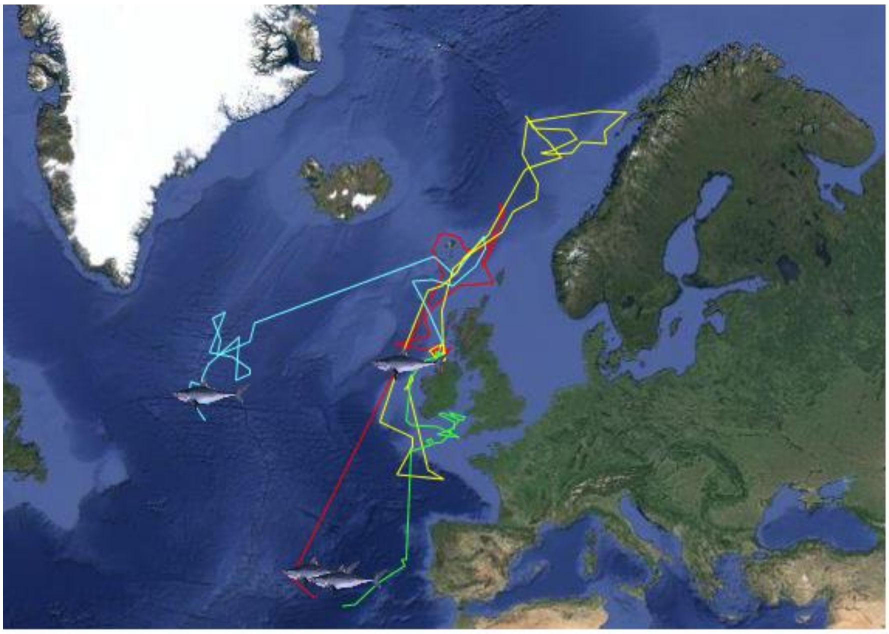

Figure 6.1a. Porbeagle in the Northeast Atlantic. Movement of porbeagle tagged in Irish porbeagle archival tagging programme.

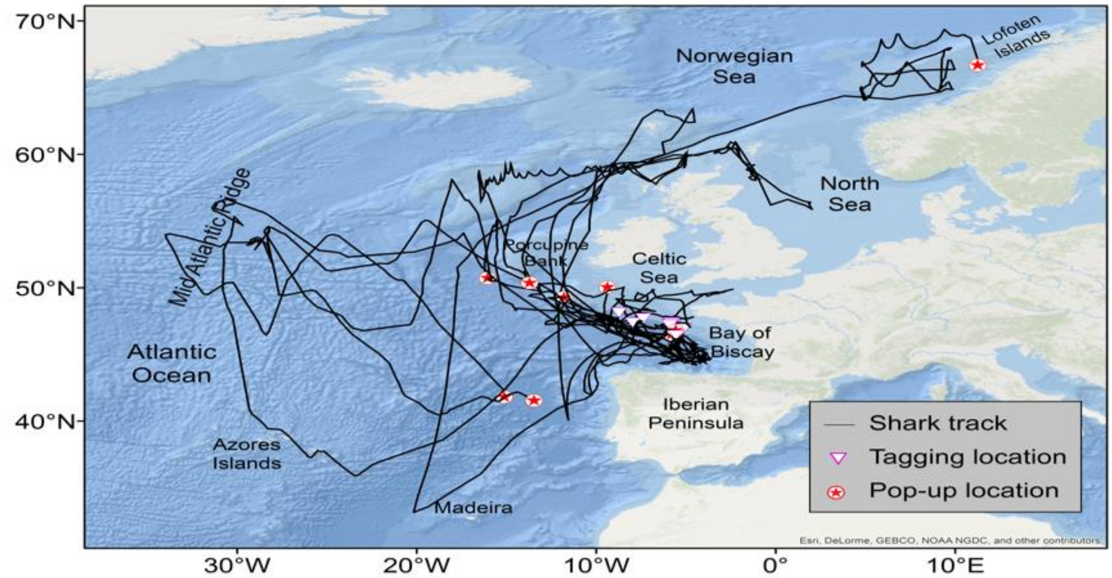

Figure 6.1b. Porbeagle in the Northeast Atlantic. Movement of porbeagle tagged in French porbeagle archival tagging programme (Biais *et al.*, 2017).

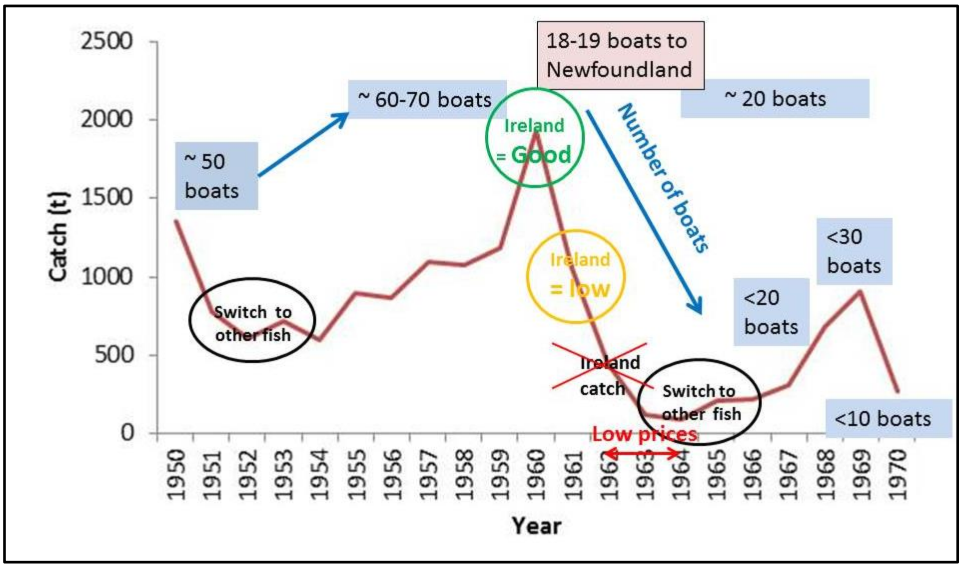

Figure 6.2 Porbeagle in the Northeast Atlantic. Trend in Norwegian catch and information on the fishery (1950–1970). Source: Biais *et al.* (2015a WD).

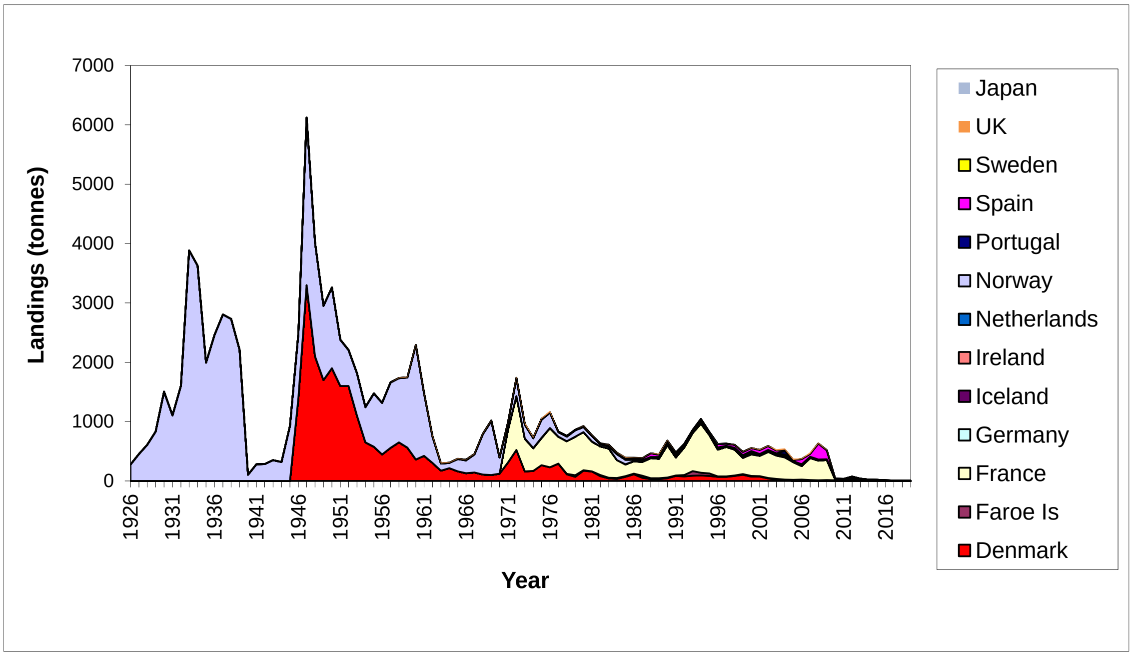

Figure 6.3. Porbeagle in the Northeast Atlantic. Working Group estimates of longer term trend in landings of porbeagle in the Northeast Atlantic (1926–2019).

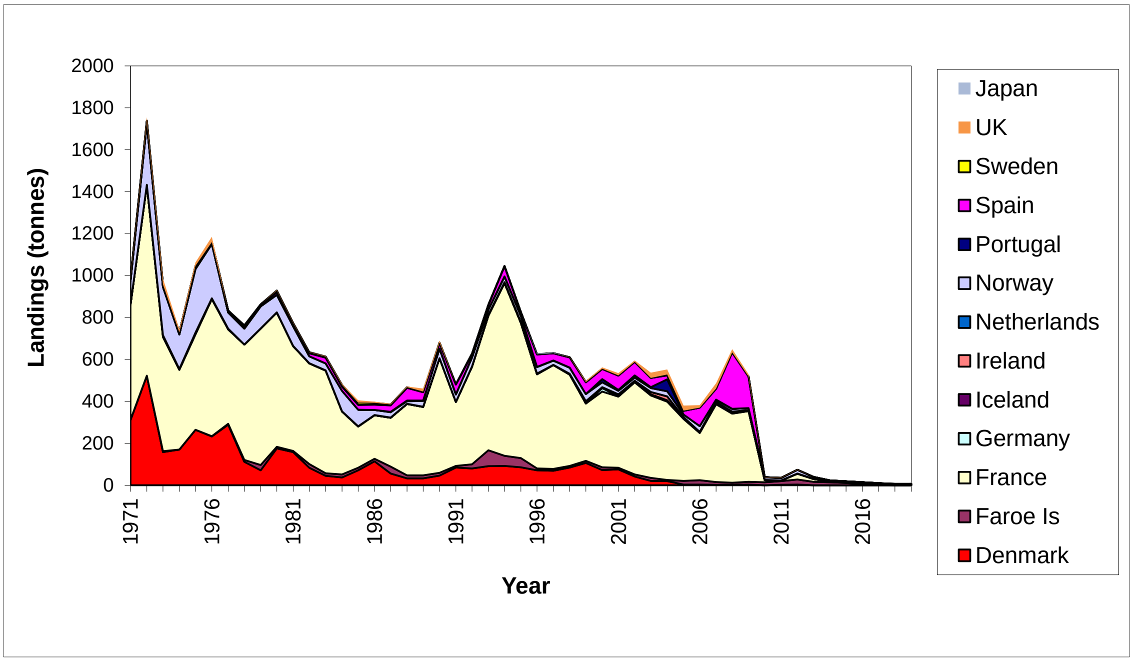

Figure 6.4. Porbeagle in the Northeast Atlantic. Working Group estimates of landings of porbeagle in the Northeast Atlantic for 1971–2019 by country.

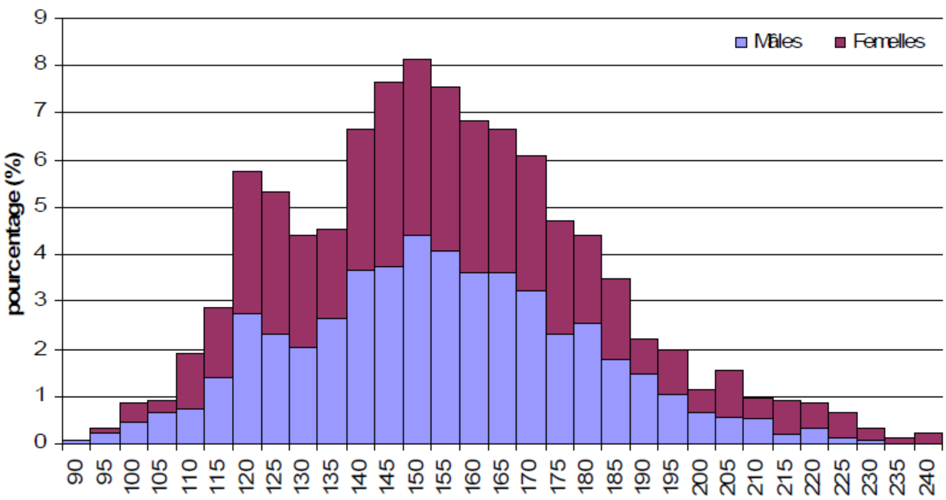

Figure 6.5. Porbeagle in the Northeast Atlantic. Length–frequency distribution of the landings of the Ile d'Yeu target fishery for porbeagle (2008–2009; n = 1769). Source: Hennache and Jung (2010).

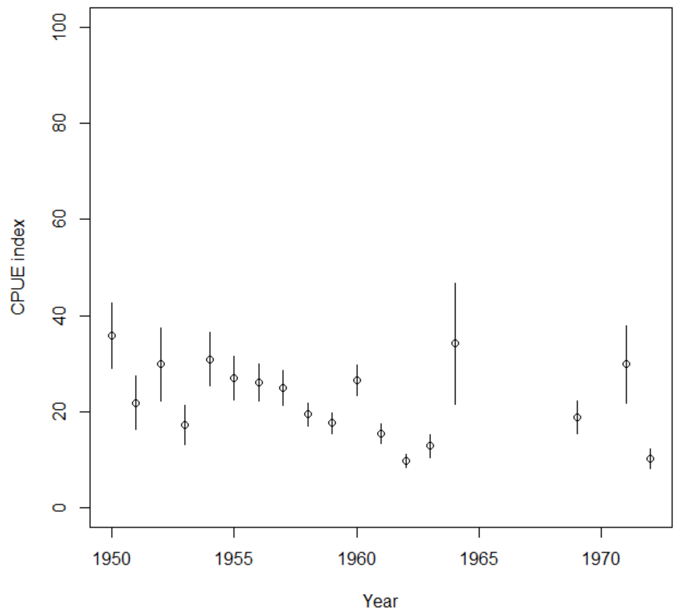

Figure 6.6. Porbeagle in the Northeast Atlantic. Temporal trends in a CPUE index for the Norwegian target longline fishery for porbeagle (1950–1972) in the northern European waters (divisions 2.a, 4.a-b, 5.a and 6.a (North of 59°N)). Source: Biais *et al.* (2015b WD).

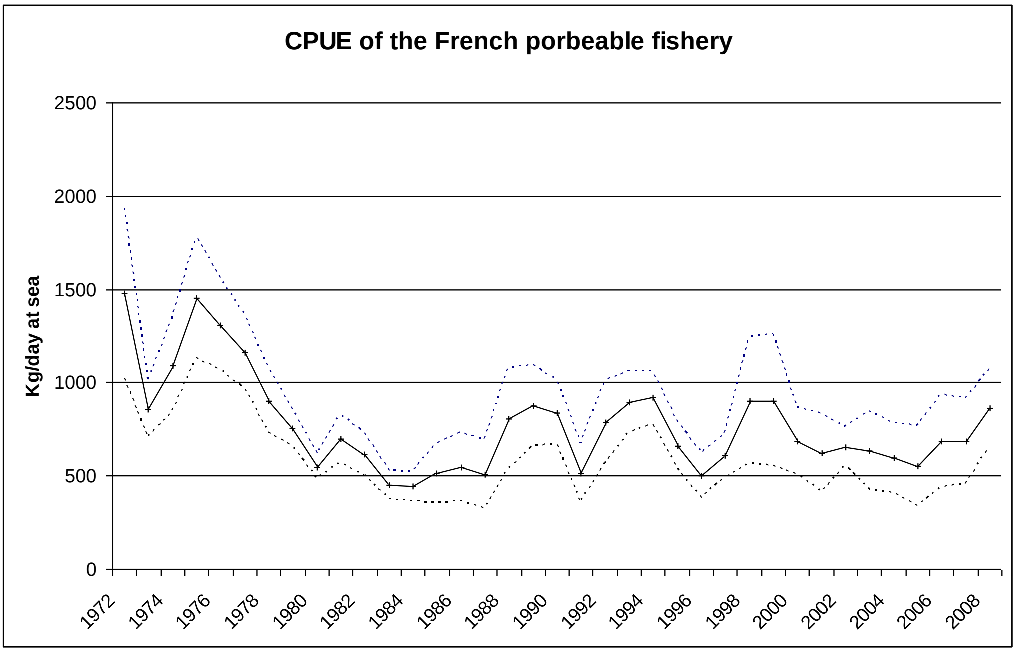

Figure 6.7. Porbeagle in the Northeast Atlantic. Nominal CPUE (kg/day at sea) for porbeagle taken in the French fishery (1972–2008) with confidence interval (±2 SE of ratio estimate). Source: Biais and Vollette (2009 WD).

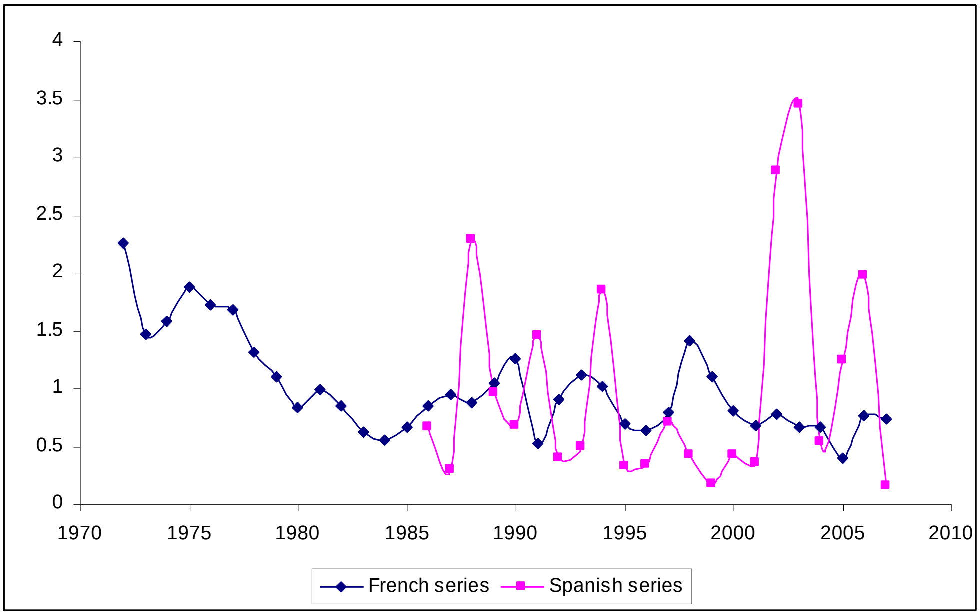

Figure 6.8. Porbeagle in the Northeast Atlantic. Temporal trends in standardized CPUE for the French target longline fishery for porbeagle (1972–2007) and Spanish longline fisheries in the Northeast Atlantic (1986–2007). Source: ICCAT (2009).

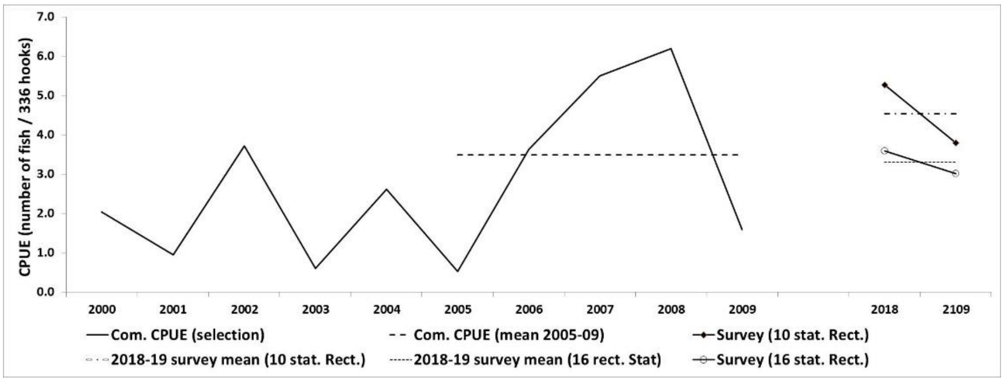

Figure 6.9. Porbeagle in the Northeast Atlantic. Survey CPUE (in number of porbeagles per long line set of 336 hooks) in 2018–2019 and the commercial CPUE series in 2000–2009 built with selections to make it comparable to the survey indices. Two survey CPUEs are shown, one for the entire survey area including 16 statistical rectangles and one including 10 statistical rectangles, which excluded those rectangles with mean CPUEs of less than 1 fish/336 hooks in 2018 or less than 1.5 fish/336 hooks in 2019. Source: Biais, 2019 WD.

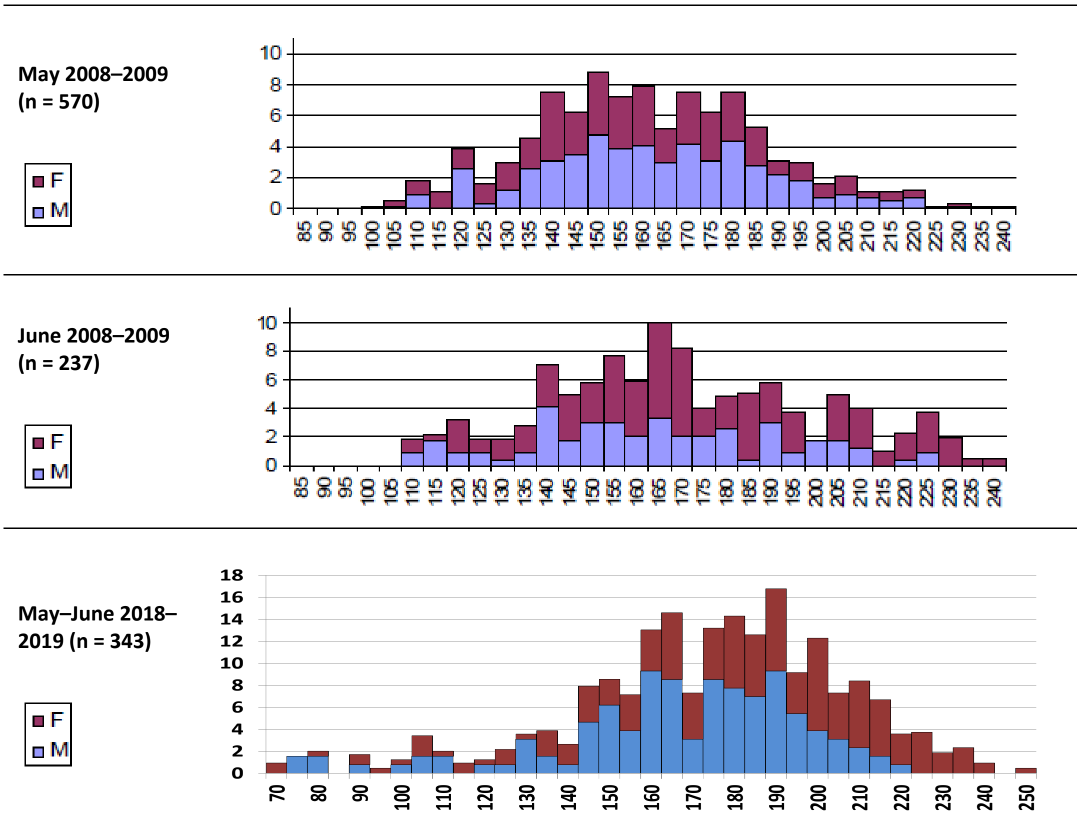

Figure 6.10. Porbeagle in the Northeast Atlantic. Length distribution (in %) of the porbeagle French catches in May and June 2008–2009 (source Hennache and Jung, 2010) and of the porbeagle survey in May and June 2018–2019 (source Biais, 2019 WD). Note: Length relates to curved fork length in cm.